European Journal of Clinical Microbiology & Infectious Diseases
https://doi.org/10.1007/s10096-020-04127-9

BRIEF REPORT

Variations in respiratory pathogen carriage among a homeless population in a shelter for men in Marseille, France, March–July 2020: cross-sectional 1-day surveys

Tran Duc Anh Ly [1,2] • Van Thuan Hoang [1,2,3] • Ndiaw Goumballa [1,4] • Meriem Louni [1,2] • Naomie Canard [1,2] • Thi Loi Dao [1,2,5] • Hacene Medkour [2,6] • Audrey Borg [2] • Kevin Bardy [2] • Véra Esteves-Vieira [2] • Véronique Filosa [2] • Bernard Davoust [2,6] • Oleg Mediannikov [2,6] • Pierre-Edouard Fournier [1,2] • Didier Raoult [1,2,6] • Philippe Gautret [1,2]

Received: 17 August 2020 / Accepted: 13 December 2020

Abstract

We aimed to compare respiratory pathogen carriage by PCR during three different time periods in 2020 in sheltered homeless people in Marseille, France. The overall prevalence of respiratory pathogen carriage in late March–early April (69.9%) was significantly higher than in late April (42.3%) and mid-July (45.1%). Bacterial carriage significantly decreased between late March–early April and late April. SARS-CoV-2 was detected only in late March–early April samples (20.6%). Measures aiming at mitigating SARS-CoV-2 transmission were effective and also impacted bacterial carriage. Seasonal variations of bacterial carriage between winter and summer in this population were not marked.

Keywords Homeless · Respiratory pathogen carriage · PCR · Seasonal variations · Respiratory symptoms · Fever

Introduction

Crowded conditions in shelters without specific preventive measures could facilitate the transmission of respiratory pathogens [1–3]. In previous studies conducted by our team during the winter over the past two decades, we observed a high prevalence of respiratory symptoms and signs [1] and high carriage rates of both respiratory viruses [2] and bacteria [3] among a sheltered homeless population in Marseille, France. Seasonal variations of the microbial community in the airways of adults and children have been described in other populations [4, 5].

Homeless shelter A contains 283 places including emergency (overnight stay) units with a rapid turnover (7–14 nights) and special (permanent stay) units dedicated to high-risk sedentary homeless persons characterized by a high level of poverty, poor hygiene, alcoholism, mental illness and chronic diseases. In Marseille, the first case of COVID-19 in the general population was diagnosed on 3 March 2020. The epidemic peaked during the first week of April, remained active until the end of April and strongly reduced in July [6]. All residents were placed under strict lockdown from 17 March to 11 May, in 2020, as for the entire French population. Based on the preliminary information that some homeless persons from this shelter presented with COVID-19 symptoms, we organized a screening campaign in collaboration with the staff in charge of these shelters. In this study, we aimed to compare clinical respiratory symptoms and respiratory viral and bacterial carriage during three different time periods (in early period of lockdown, in late period of lockdown, in summer) in the same population of sheltered homeless people in Marseille, France.

✉ Philippe Gautret
philippe.gautret@club-internet.fr

1 IRD, AP-HM, SSA, VITROME, Aix Marseille Univ, Marseille, France

2 IHU-Méditerranée Infection, Marseille, France

3 Family Medicine Department, Thai Binh University of Medicine and Pharmacy, Thai Binh, Vietnam

4 VITROME, Campus International IRD-UCAD de l'IRD, Dakar, Senegal

5 Pneumology Department, Thai Binh University of Medicine and Pharmacy, Thai Binh, Vietnam

6 IRD, AP-HM, SSA, MEPHI, Aix Marseille Univ, Marseille, France

Published online: 13 February 2021

Methods

Study population Cross-sectional 1-day surveys were organized in late March–early April (from 31 March to 6 April), late April (22 and 23 April) and mid-July (16 July 2020) at shelter A. Homeless people were recruited on a voluntary basis. Medical staff administrated a standardized questionnaire addressing demographic information (sex, age, country of origin) and any respiratory symptoms or fever (temperature measured ≥ 37.8 °C) in the 2 weeks prior to sampling. Nasal samples were systematically collected on transport media using Sigma-Virocult® (Medical Wire, Corsham, UK).

PCR assay Real-time reverse transcription-PCR amplification was used to confirm the presence of six bacteria (*Moraxella catarrhalis, Staphylococcus aureus*, *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae* [7] and *Acinetobacter baumannii* [8] and eight types of viruses (SARS-CoV-2 [9], influenza A [FluA], influenza B [FluB], human rhinovirus [HRV], human metapneumovirus [HMPV], human respiratory syncytial virus [HRSV] [7], adenovirus [ADV] [10] and human coronavirus [HCoV] [11]), together with internal controls (human beta-actin gene [12] and MS2 phage [7]) as previously described. HCoV-positive samples were subsequently screened for HCoV-HKU1, HCoV-NL63, HCoV-229E and HCoV-OC43 [2]. Results with cycle threshold (CT) ≤ 35 were considered positive.

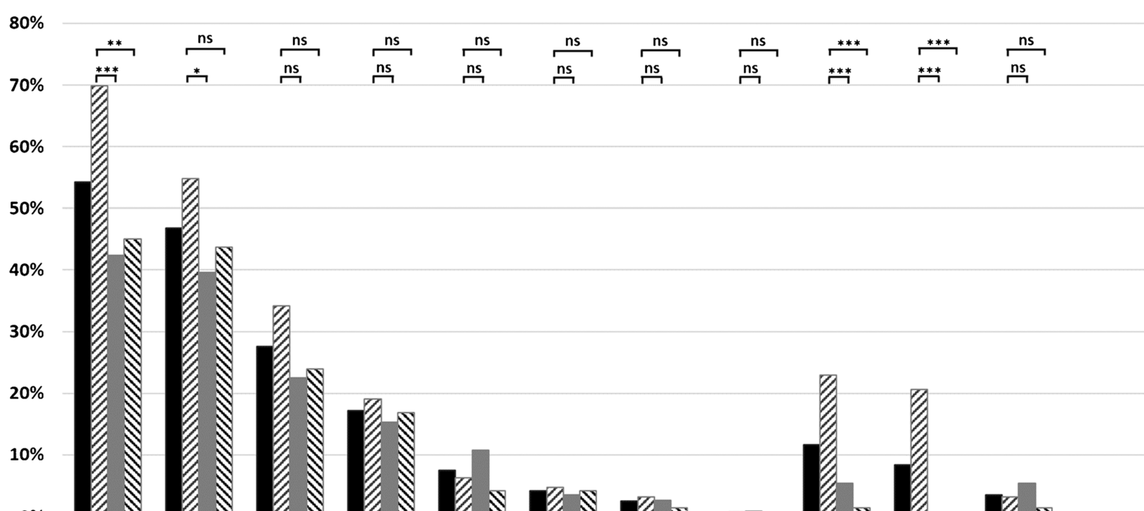
Statistical analysis Statistical procedures were performed using STATA 11.1. We used Pearson's chi-square or Fisher's exact tests to compare differences of percentage between two groups of individuals where appropriate. The chi-square test for R by C table was used to compare the differences of proportions within three groups. Means of quantitative data within three groups were compared using analysis of variance (ANOVA test). A two-sided p value of less than 0.05 was considered statistically significant.

Results

Overall, 207 homeless persons agreed to participate and underwent nasal sampling at least on one date, accounting for an estimated 56% of homeless people living at the shelter at the time of enrolment. Of those, 126 were recruited in late March–early April, 111 in late April and 71 in mid-July. Only 17 of 207 (13.4%) individuals were tested three times (Supplementary Figure 1).

Demographics, chronic conditions and clinical status (Table 1)

All individuals were male with a mean age of 47.1 years, originating mostly from the African continent (67.6%). There was no significant variation of age and birthplace according to sampling time. Regarding clinical findings, the highest symptom prevalence was observed in late March–early April, with 38.1% reporting at least one respiratory symptom or fever. The symptom prevalence decreased to 11.7% in late April and 5.6% in mid-July.



	At least one pathogens	At least one bacteria	M. catarrhalis	S. aureus	H. influenzae	S. pneumoniae	K. pneumoniae	A. baumannii	At least one virus	SARS-CoV-2	HRV	Other viruses
All samples (N=308)	54.2%	46.8%	27.6%	17.2%	7.5%	4.2%	2.6%	0.6%	11.7%	8.4%	3.6%	0.0%
Late March-early April (N=126)	69.8%	54.8%	34.1%	19.0%	6.3%	4.8%	3.2%	0.8%	23.0%	20.6%	3.2%	0.0%
Late April (N=111)	42.3%	39.6%	22.5%	15.3%	10.8%	3.6%	2.7%	0.9%	5.4%	0.0%	5.4%	0.0%
Mid July (N=71)	45.1%	43.7%	23.9%	16.9%	4.2%	4.2%	1.4%	0.0%	1.4%	0.0%	1.4%	0.0%

Fig. 1 Prevalence of respiratory pathogen carriage according to dates of inclusion (ns: p value > 0.05; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; other viruses include FluA, FluB, MPV, HRSV, ADV, HCoV-HKU1, HCoV-NL63, HCoV-229E and HCoV-OC43)

Table 1 Characteristics of homeless population according to dates of inclusion

Characteristics		Total screened N=207	Late March–early April N=126	Late April N=111	Mid-July N=71	p value[1]
Age (years) (204)	Range (min-max)	21–94	21–91	21–91	24–91	
	Mean ± SD	47.1±16.0	46.2±16.0	48.5±15.5	46.6±16.9	0.527
Birthplace (207)	Europe, n (%)	56 (27.1)	32 (25.4)	34 (30.6)	19 (26.8)	0.9
	Africa, n (%)	140 (67.6)	85 (67.5)	72 (64.9)	48 (67.8)	
	Asia, n (%)	10 (4.8)	8 (6.3)	4 (3.6)	4 (5.6)	
	America, n (%)	1 (0.5)	1 (0.8)	1 (0.9)	0 (0)	
Presence of respiratory symptom and fever (207)	At least one symptom, n (%)	N/A	40 (31.8)	13 (11.7)	4 (5.6)	$<10^{-4}$
	Cough n (%)		19(15.1)	6 (5.4)	3 (2.8)	0.009
	Rhinorrhoea, n (%)		15(11.9)	5 (4.5)	0 (0)	0.003
	Dyspnoea, n (%)		11 (8.7)	1 (0.9)	0 (0)	0.003
	Sore throat, n (%)		6 (4.7)	2 (1.8)	0 (0)	0.1
	Fever, n (%)		10 (7.9)	1 (0.9)	1 (1.4)	0.009

Abbreviation: *SD* standard deviation, *N/A* not applicable

[1] Comparison within the three periods of inclusion

[2] Number of individuals for whom data was available

Prevalence of respiratory pathogens by real-time PCR (Fig. 1)

Overall, 167 (54.2% of total samples, $n = 308$) tested positive for at least one pathogen (Fig. 1). *M. catarrhalis* was the pathogen most frequently detected, with 27.6% of all samples testing positive, followed by *S. aureus* (17.2%) and *H. influenzae* (7.5%). Among the viruses, high positivity rates were observed for SARS-CoV-2 (8.4%). The percentage of individuals who tested positive for HRV was 3.6%; other viruses were negative.

The overall prevalence of respiratory pathogen carriage in late March–early April (69.9%) was significantly higher than in late April (42.3%) and mid-July (45.1%). Bacterial carriage significantly decreased between late March–early April and late April. SARS-CoV-2 was detected only in late March–early April samples (20.6%). Bacterial carriage was not significantly different between SARS-CoV-2 positive samples (42.7%) and SARS-CoV-2 negative samples (47.1%), with p value = 0.78. No deaths were reported during the study period.

Measures to mitigate the risk of SARS-COV-2 transmission

Measures to mitigate the risk of transmission in the homeless population that were undertaken included strict lockdown, avoiding gatherings of persons at the shelter, wearing a mask in public, maintaining distance from others, washing hands with soap and water frequently and for at least 20 s, practicing cough etiquette and avoiding touching the eyes, nose or mouth with unwashed hands. Individuals testing positive for SARS-CoV-2 were moved to special facilities for COVID-19 homeless patient isolation or kept in single rooms at the shelter with strict isolation measures for 14 days.

Discussion

As in previous studies conducted in sheltered homeless populations in Marseille, we observed high rates of bacterial colonization and comparatively very low rates of common virus carriage [3]. High carriage rates of SARS-CoV-2 were observed, confirming that homeless people are at high risk for COVID-19 [13, 14]. The secondary bacterial infections are potentially common among SARS-CoV-2 (or SARS-CoV or MERS-CoV) patients [15] but the bacterial carriage did not significantly differed between SARS-CoV-2 carriers and those negative for this virus in our study.

Measures aimed at mitigating SARS-CoV-2 transmission were very effective, and no new case was documented during the last two sampling campaigns. Similar shelter-based infection control measures were recommended in Boston, USA [16]. In a UK study, the multivariable probabilistic sensitivity analysis suggested that such measures could avoid many deaths and infections in homeless shelters [17]. Interestingly, a transient but significant decrease of bacterial carriage was also observed in April. To the best of our knowledge, no study has reported the effects of measures aimed at mitigating SARS-CoV-2 transmission on the variation of respiratory bacterial carriage in the context of homeless shelters. Bacterial colonization tended to increase again in July, suggesting that seasonal variations of bacterial carriage between winter and summer in this population are not marked.

Our study has several limitations. Notably, the population was not randomly and homogenously recruited. The proportion of paired samples was very low, due to the high mobility of this group and a low acceptance rate during the last two sampling campaigns. The medical histories of participants and individual adherence to preventive measures were not documented.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10096-020-04127-9.

Acknowledgements We thank our co-workers at the University Hospital Institute (IHU) who assisted us in recruiting, interviewing and examining participants and collecting samples.

Authors' contributions TD and PG contributed to experimental design, data analysis, statistics, interpretation and writing. VT, NG, ML, NC, TL, HM, AB, KB, VE, VF, BD, OM and PEF administered questionnaires, examined patients and collected samples. AB, KB and VE provided technical assistance. OM, PEF, DR and PG contributed to critically reviewing the manuscript. PG coordinated the work.

Funding This work was supported by the French Government under the "Investissements d'avenir" (Investments for the Future) program managed by the ANR (Agence Nationale de la Recherche [National Research Agency]) (Reference: Méditerranée Infection 10-IAHU-03).

Data availability Not applicable.

Compliance with ethical standards

Conflict of interest No reported conflicts of interest.

Ethics approval Ethical approvals were obtained from the Institutional Review Board and Ethics Committee of Marseille (2010-A01406–33).

Consent to participate Not applicable.

Consent for publication Not applicable.

Code availability Not applicable.

References

1. Badiaga S, Richet H, Azas P et al (2009) Contribution of a shelter-based survey for screening respiratory diseases in the homeless. Eur J Pub Health 19(2):157–160
2. Thiberville S, Ninove L, Hai Vinh V et al (2012) The viral etiology of an influenza-like illness during the 2009 pandemic. J Med Virol 84:1071–1079
3. Ly TDA, Edouard S, Badiaga et al (2019) Epidemiology of respiratory pathogen carriage in the homeless population within two shelters in Marseille, France, 2015–2017: cross sectional 1-day surveys. Clin Microbiol Infect 25(2):249.e1–249.e6
4. Marchisio P, Gironi S, Esposito S et al (2001) Seasonal variations in nasopharyngeal carriage of respiratory pathogens in healthy Italian children attending day-care centres or schools. J Med Microbiol 50:1095–1099
5. Abdullahi O, Nyiro J, Lewa P, Slack M, Scott JA (2008) The descriptive epidemiology of Streptococcus pneumoniae and Haemophilus influenzae nasopharyngeal carriage in children and adults in Kilifi District, Kenya. Pediatr Infect Dis J 27:59e64
6. Santé Publique France (2020) COVID-19 [COVID-19: epidemiological update of 30 July 2020]. St Maurice : Santé Publique France ; 30 July 2020. French. Available from : https://www.gouvernement.fr/info-coronavirus/carte-et-donnees
7. Hoang VT, Dao TL, Ly TDA et al (2019) The dynamics and interactions of respiratory pathogen carriage among French pilgrims during the 2018 Hajj. Emerg Microbes Infect 8(1):1701–1710
8. Ly TDA, Kerbaj J, Edouard S et al (2019) The presence of *Acinetobacter baumannii* DNA on the skin of homeless people and its relationship with body lice infestation. Preliminary Results. Front Cell Infect Microbiol 9:86
9. Amrane S, Tissot-Dupont H et al (2020) Rapid viral diagnosis and ambulatory management of suspected COVID-19 cases presenting at the infectious diseases referral hospital in Marseille, France, − January 31st to March 1st, 2020: A respiratory virus snapshot. Travel Med Infect Dis:101632. https://doi.org/10.1016/j.tmaid.2020.101632
10. Dao TL, Hoang VT, Ly TDA et al (2020) Infectious disease symptoms and microbial carriage among French medical students travelling abroad: a prospective study. Travel Med Infect Dis 34:101548
11. World heath organisation (2020) Detection of 2019 novel coronavirus (2019-nCoV) in suspected human cases by RT-PCR. https://www.who.int/docs/default-source/coronaviruse/peiris-protocol-16-1-20.pdf?sfvrsn=af1aac73_4 Accessed 17 August 2020
12. Morel AS, Dubourg G, Prudent E et al (2015) Complementarity between targeted real-time specific PCR and conventional broad-range 16S rDNA PCR in the syndrome-driven diagnosis of infectious diseases. Eur J Clin Microbiol Infect Dis 34:561–570. https://doi.org/10.1007/s10096-014-2263-z
13. Peate I (2020) Self-isolation and the homeless population. Br J Nurs 29(7):387
14. Wood LJ, Davies AP, Khan Z (2020) COVID-19 precautions: easier said than done when patients are homeless. Med J Aust 212(8):384–384.e1
15. Manohar P, Loh B, Nachimuthu R et al (2020) Secondary bacterial infections in patients with viral pneumonia. Front Med 7:420
16. Baggett TP, Racine MW, Lewis E et al (2020) Addressing COVID-19 among people experiencing homelessness: description, adaptation, and early findings of a multiagency response in Boston. Public Health Rep 135(4):435–441
17. Lewer D, Braithwaite I, Bullock M et al (2020) COVID-19 among people experiencing homelessness in England: a modelling study. Lancet Respir Med S2213-2600(20):30396–30399